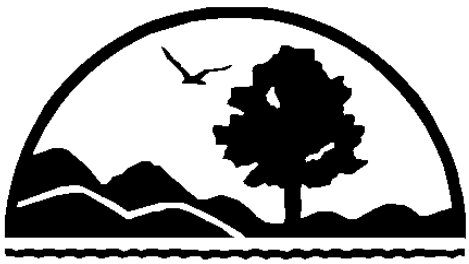
WATER QUALITY STUDY OF THE EAST FORK LITTLE SANDY RIVER



Natural Resources and Environmental Protection Cabinet
Kentucky Division of Water

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WATER QUALITY STUDY OF THE EAST FORK LITTLE SANDY RIVER

KENTUCKY DEPARTMENT FOR ENVIRONMENTAL PROTECTION
DIVISION OF WATER
WATER QUALITY BRANCH

Frankfort, Kentucky

This report has been approved for release:

Jack A. Wilson, Director
Division of Water

March 10, 1992
Date

WATER QUALITY STUDY
OF THE
EAST FORK LITTLE SANDY RIVER
(MILE 25.4 TO MILE 17.0

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Table of Contents

LIST OF FIGURES

LIST OF TABLES

Abstract

There are 50 wastewater treatment plants located in the East Fork of the Little Sandy River. Forty of these are located between river miles 25 to 19, an area experiencing rapid growth and development. Water quality modeling indicates this area does not meet Kentucky's water quality standard for dissolved oxygen during low flow summertime conditions. The Division of Water conducted a water quality survey in August 1991 to verify model predictions.

Dissolved oxygen violations were measured in the East Fork at mile 25.4, mile 20.0, and mile 17.0. Violations were also measured in Shope Creek. The source of these violations is attributed to package wastewater treatment plants. An oil sheen was visible at all the sampling sites on the East Fork, but the source was not discovered. Dissolved solids were high in Big Run, which also raised dissolved solids in the East Fork below Big Run. Flow from surface mines and possibly a large landfill in the Big Run drainage area are the likely sources of these constituents. Completion of a sewer line extension that will eliminate many of the package wastewater facilities is expected to significantly improve water quality. A follow up study is recommended after this occurs to determine if problems with oil and dissolved solids persist.

INTRODUCTION

The East Fork of the Little Sandy River begins in Lawrence County and flows 45 miles to its confluence with the Little Sandy River in Greenup County (Figure 1). A portion of the basin in Boyd County near Ashland is experiencing rapid growth and development. This area, from about river mile 25 to mile 19, is not served by a centralized wastewater treatment system. Package wastewater treatment systems have been installed to meet the needs of individual developments. Currently there are 40 package facilities within this area, serving schools, mobile home parks, apartment complexes, commercial establishments, and subdivisions. Design flows range from only 500 gallons per day (gpd) to 50,000 gpd. Small package facilities are generally inefficient and difficult for individual owners to maintain. Some of these facilities are aging and do not operate properly.

For several years the Division of Water (Division) has been notifying local governments and developers of water quality problems occurring in the basin. Water quality model results indicate that this section of the river and some of its tributaries do not meet Kentucky's water quality standard for dissolved oxygen (DO). Based on these results, requests for new wastewater facilities or expansions of existing facilities are being denied. Denials are based on provisions contained in Kentucky Water Quality Regulations, Title 401, Chapters 5:005 Section 7(3)and 5:055 Section 2(3). Because of this situation, the Division has worked

with Boyd County and the City of Ashland to extend sewers to this area and eliminate these package facilities. Design plans for this extension have been received by the Division and are under review. Full completion of the project is expected to take two to three years.

In August 1991, the Division conducted a water quality survey of this section of the East Fork to verify the low DO levels predicted by the model. This report presents the results of the study.

DESCRIPTION OF STUDY AREA

The East Fork drains an area of 154 square miles, primarily in Lawrence, Boyd, and Greenup Counties. There are 50 package wastewater facilities in the basin, with 40 of these concentrated close together in the reach from about river mile 25 to mile 19, near Ashland, Ky. Shope Creek, a tributary to the East Fork at mile 20.8, has 26 of these facilities within its basin. Shope Creek parallels Highway 60, near Ashland, which is the fastest growing area in the county. Locations of these facilities are noted on Figure 1 and described in Table 1. The East Fork also encompasses areas of strip mining, oil and gas production, and has a tributary stream that drains a large landfill.

Stream slopes are fairly steep in the headwaters of the basin, but become very flat, to less than 5 feet per mile (ft/mi), below mile 25. The East Fork is characterized by short riffles between long, sluggish pools. Streamflow during the low-flow season is

Figure 1. East Fork Little Sandy

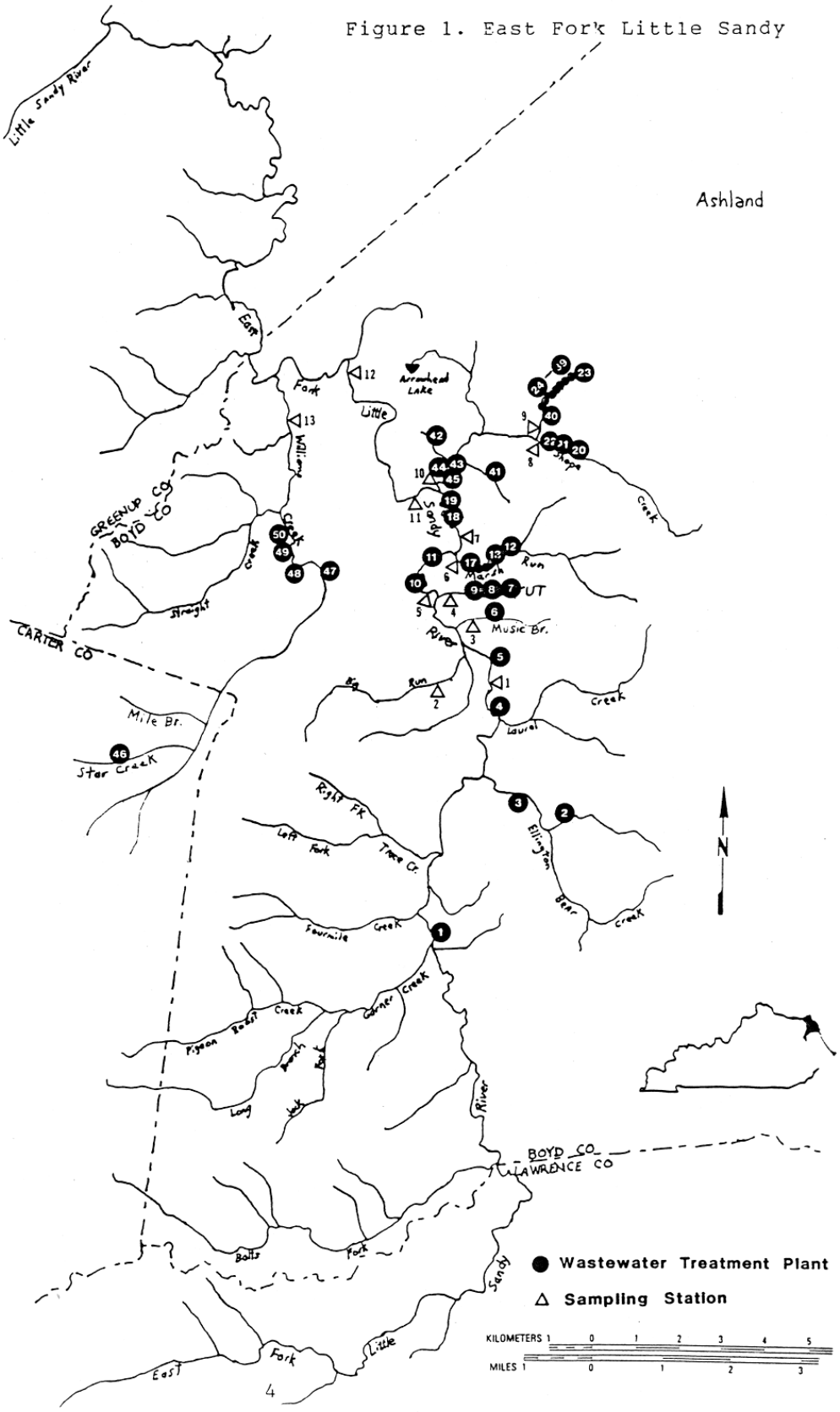


TABLE I. WASTEWATER FACILITIES IN THE EAST FORK LITTLE SANDY RIVER

MAP	NAME	DESIGN FLOW (MGD)	STREAM NAME
1	GARNER ELEMENTARY	0.00300	EAST FORK
2	BOYD CO. ELEMENTARY	0.00450	TRIB. TO ELLINGTON CREEK
3	BEAR CREEK C.C.	0.03000	ELLINGTON BEAR CREEK
4	HIDDEN VALLEY MHP	0.00900	EAST FORK
5	STANDARD STATION	0.00100	EAST FORK
6	BOYD CO. VOCATIONAL	0.04600	MUSIC BRANCH
7	BOYD CO. HIGH SCHOOL	0.02200	TRIB. TO EAST FORK
8	BOYD CO. GARAGE	0.00100	TRIB. TO EAST FORK
9	CANNONSBURG ELEMENTARY	0.00600	TRIB. TO EAST FORK
10	FARM & GARDEN CENTER	0.01500	EAST FORK
11	WHAYNE SUPPLY CO.	0.00400	EAST FORK
12	GREEN TREE MHP	0.00600	MARSH RUN
13	COUNTRY LANES	0.00100	MARSH RUN
14	TOMCO APTS	0.01000	MARSH RUN
15	TUDOR OAKS APTS	0.01200	MARSH RUN
16	WHEELER & WILLIAMS	0.00100	MARSH RUN
17	PIGGLY WIGGLY	0.00400	MARSH RUN
18	LIQUID TRANSPORTERS	0.00100	EAST FORK
19	ASHLAND MALL	0.05000	EAST FORK
20	GREEN VALLEY #1	0.01200	SHOPE CREEK
21	RENEE MHP	0.00500	SHOPE CREEK
22	GREEN VALLEY #2	0.01200	SHOPE CREEK
23	BOYD CO. LIBRARY	0.00100	TRIB. TO SHOPE CREEK
24	PARADISE LANES	0.00150	TRIB. TO SHOPE CREEK
25	KY STATE POLICE	0.00100	TRIB. TO SHOPE CREEK
26	THIRD NATIONAL BANK	0.00100	TRIB. TO SHOPE CREEK
27	JAY'S MARKET	0.00400	TRIB. TO SHOPE CREEK
28	CRIPS DAIRY TREAT	0.00100	TRIB. TO SHOPE CREEK
29	SAVE MART	0.00100	TRIB. TO SHOPE CREEK
30	SUMMIT CHURCH	0.00100	TRIB. TO SHOPE CREEK
31	COMMERCIAL BUILDING	0.00300	TRIB. TO SHOPE CREEK
39	TACO JOHNS	0.00500	TRIB. TO SHOPE CREEK
33	FIRST AMERICAN BANK	0.00050	TRIB. TO SHOPE CREEK
34	SUMMIT MEDICAL BLD.	0.00200	TRIB. TO SHOPE CREEK
35	GIOVANNIS PIZZA	0.00150	TRIP. TO SHOPE CREEK
36	JAYS TRAILER PARK	0.00150	TRIE. TO SHOPE CREEK
37	KNIGHTS INN MOTEL	0.01200	TRID. TO SHOPE CREEK
38	SUMMIT FOODLAND	0.00150	TRIB. TO SHOPE CREEK
39	SUMMIT JUNIOR HIGH	0.00650	TRIB. TO SHOPE CREEK
40	BOYD CO. AMBULANCE	0.00100	TRIB. TO SHOPE CREEK

TABLE 1. WASTEWATER FACILITIES IN THE EAST FORK LITTLE SANDY RIVER
(Continued)

MAP	NAME	DESIGN FLOW (MGD)	STREAM NAME
41	ROC-KEL APTS	0.00500	TRIB. TO SHOPE CREEK
42	HALL RIDGE MHP	0.00750	STEVENS HOLLOW
43	FIRST BANK AND TRUST	0.00050	SHOPE CREEK
44	FAIRHILL ESTATES	0.01600	SHOPE CREEK
45	MR. GATTIS PIZZA	0.00600	SHOPE CREEK
46	STAR ELEMENTARY	0.00500	STAR CREEK
47	HYLAND CO.	0.01000	WILLIAMS CREEK
48	THREE SISTERS MHP	0.00160	WILLIAMS CREEK
49	PRINCELAND SWIM CLUB	0.00500	WILLIAMS CREEK
50	SIXTY FOUR SERVICE CEN.	0.00200	WILLIAMS CREEK

minimal. The U.S. Geological Survey (USGS) has published streamflow data for streams in Kentucky, and report a 7-day 10-year (7QIO) low flow of 0. 0 cubic feet per second (cfs) at mile 37.8 and 0.40 cfs at mile 7.5 (8). Streams such as the East Fork do not have a high assimilative capacity to accept wastewater discharges. Slopes on tributaries are steeper, especially in the headwater regions. Streams with steep slopes have higher velocities and greater reaeration, and are better able to accept wastewater discharges without experiencing water quality problems. However, these slopes are reduced considerably near the confluence with the East Fork. For example, slope on the tributary of Shope Creek at mile 1.7 is about 87 ft/mi, while the slope on Shope Creek near its mouth is only about 9 ft/mi.

DATA COLLECTION

Streamflow and water quality measurements were made at 13 sites in the reach of the East Fork from mile 25.4 to mile 17.0 on August 6 to August 8, 1991 (Figure 1, Table 2). Weather conditions were hot and sunny to partly cloudy, and streamflow conditions were low. No significant rainfall had occurred for at least two weeks prior to the study. Instantaneous measurements for DO, water temperature, pH, and specific conductance were made using a Hydrolab 4041 portable water quality meter that had been calibrated the day prior to the study. Quality control measurements using the Winkler titration method were done at the first site each morning and periodically during the day to ensure meter accuracy. DO and

water temperature were also measured hourly f or periods ranging from 19 to 22 hours at four locations in the East Fork using two Hydrolab Datasonde I units. These units were calibrated to manufacturers' specifications the day prior to the study, and instantaneous DO measurements were made when setting and removing the units to ensure data accuracy. Sonde units were set in the East Fork at mile 22.8, at mile 21.6, at mile 20.0, and at mile 17.0. Data from these units were downloaded to an IBM PC for analysis. Streamflow was measured using a Teledyne-Gurley flow meter that had been spin tested prior to use, and utilizing USGS methodology. one water sample was collected in Big Run because of elevated specific conductance values. The sample was analyzed for alkalinity, chloride, sulfate, calcium, and sodium.

TABLE 2. LOCATION OF WATER QUALITY SAMPLING STATIONS

Map #	Location
1	East Fork at I-64, mile 25.4
2	Big Run on county road, mile 0.4
3	Music Branch off Hwy 180, near mouth
4	Unnamed trib. to East Fork at mile 24.3, near mouth
5	East Fork at Hwy 60, mile 22.8
6	Marsh Run at Hwy 60, near mouth
7	East Fork off Hwy 60, mile 21.7
8	Shope Creek off Hwy 538, mile 1.8
9	Unnamed trib. To Shope Creek at mile 1.7, near mouth
10	Shope Creek off Hwy 60, mile 0.4
11	East Fork on county road, mile 20.0
12	East Fork on county road, mile 17.0
13	Williams Creek on Hwy 5, mile 0.7

WATER QUALITY

Measurements and observations made during this study indicate that water quality in the study area of the East Fork of the Little Sandy River is poor during low-flow, summertime conditions. Kentucky's criteria for DO were violated in the East Fork at mile 25.4, at mile 20.0, and at mile 17.0. These criteria stipulate that daily average DO cannot be less than 5.0 milligrams per liter (mg/L), with no instantaneous levels below 4. 0 mg/L. Two locations in Shope Creek also violated these criteria. Table 3 and Figures 2 through 5 present this data. These violations are likely caused by the effluent from package wastewater facilities. Wastewater effluent contains oxygen-consuming carbonaceous and nitrogenous substances, and other nutrients which promote algae growth. Algae produce oxygen during daylight hours and consume oxygen at night, and large algal blooms can result in severe water quality problems.

Dissolved oxygen in the East Fork at mile 25.4 (Site 1 on Figure 1) was 4.6 mg/L on August 6 at 2:30 P.M. Normally, DO in the afternoon is much higher because of photosynthesis by algae. Weather conditions were cloudy, and there was oil on the water surface. These factors may have reduced photosynthetic activity at this site, but do not appear to have affected other sampling stations. This low DO may be the result of effluent from a mobile home park 0.6 miles upstream. This facility is known to have had operational problems in the past. In contrast, the DO in Big Run (Site 2) at mile 0.4 was 13.2 mg/L at 3:05 P.M., a clear indication of photosynthesis. Music Branch (Site 3) and the unnamed tributary

TABLE 3. WATER QUALITY CONDITIONS IN EAST FORK LITTLE SANDY RIVER

MAP #	STATION	DATE	TIME	FLOW (CFS)	DISSOLVED OXYGEN (MG/L)	WATER TEMP. (DEG. C)	SPECIFIC CONDUCTANCE (uS/CM)	pH (UNITS)
1	EAST FORK LITTLE SANDY, MILE 25.4	8-06-91	2:30 P.M.	0.11	4.6	22.4	450	7.2
2	BIG RUN AT MILE 0.4	8-06-91	3:05 P.M.	0.17	13.2	23.6	1993	8.1
3	MUSIC BRANCH NEAR MOUTH	8-06-91	2:00 P.M.	0.0				
4	TRIB. TO EAST FK LITTLE SANDY AT MILE 24.3	8-06-91	2:10 P.M.	0.0				
5	EAST FORK LITTLE SANDY, MILE 22.8	8-06-91 8-07-91	11:15 A.M. 9:15 A.M.	0.38 0.33	5.7 5.3	22.6 22.0	1075 1074	7.5 7.5
6	MARSH RUN NEAR MOUTH	8-06-91	1:45 P.M.	0.08	6.9	22.8	730	7.1
7	EAST FORK LITTLE SANDY, MILE 21.7	8-06-91 8-07-91	1:00 P.M. 9:50 A.M.	- -	9.0 6.7	24.4 22.5	770 747	7.6 7.5
8	SHOPE CREEK AT MILE 1.8	8-07-91	3:00 P.M.	0.06	3.0	29.9	834	7.4
9	TRIB. TO SHOPE CREEK, MILE 1.7	8-07-91	2:30 P.M.	0.04	9.7	27.0	670	8.4
10	SHOPE CREEK AT MILE 0.40	8-07-91	1:45 P.M.	0.03	3.2	22.2	680	7.5
11	EAST FORK LITTLE SANDY, MILE 20.0	8-07-91 8-08-91	10:20 A.M. 9:00 A.M.	0.49 -	3.4 4.0	22.4 22.6	560 575	7.5 7.5
12	EAST FORK LITTLE SANDY, MILE 17.0	8-07-91 8-08-91	11:30 A.M. 9:35 A.M.	0.89	4.3 3.9	21.4 21.7	611 624	7.5 7.5
13	WILLIAMS CREEK AT MILE 0.7	8-07-91	3:30 P.M.	0.07	8.7	29.5	625	7.6

to the East Fork at mile 24.3 (Site 4) were dry. Although the sampling sites on these streams were below wastewater facilities, these primarily serve schools which were not in session. DO in the East Fork at mile 22.8 (Site 5) was above the state criteria over a 21 hour period beginning at noon on August 6 and ending at 9:00 A.M. on August 7 (Figure 2). Oil was again observed on the water surface. A local resident indicated that the oil was recent, but he did not know its source.

The sampling site on Marsh Run (Site 6) was below six small wastewater facilities, but DO was not below criteria at the time of sampling. The site was in a pool containing matted periphytic. algae, and below a riffle area. Both factors would help increase DO, but algal respiration at night may lower Do below criteria.

DO concentration in the East Fork at mile 21.7 (Site 7) also was not below state criteria over a 19 hour period beginning at 2:00 P.M. on August 6 (Figure 3). The curve on Figure 3 is typical for streams, with a smooth upward rise to a peak in late afternoon and a slow decline before dawn. This area is a long pool exposed to full sun during daylight hours. Oil, however, was again visible on the water surface.

Shope Creek at mile 1.8 (Site 8) was septic with a strong sewage odor. The cause was improperly treated ef fluent from one or more of the upstream wastewater facilities. The tributary to Shope Creek at mile 1.7 (Site 9) did not violate DO criteria when sampled at 2:30 P.M. on August 7, despite the large number of package wastewater facilities upstream. This tributary has a steep slope

Figure 2: East Fork at Mile 22.8
DO vs Time

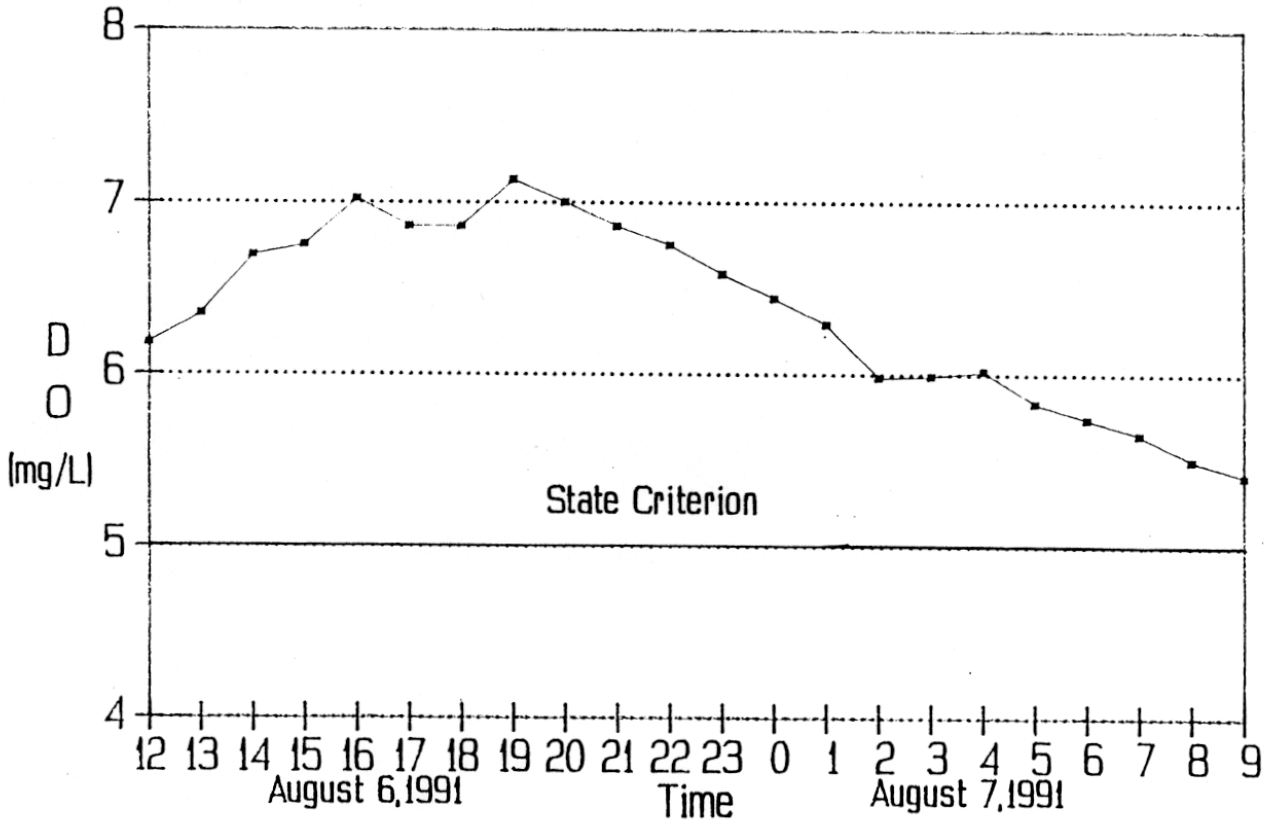
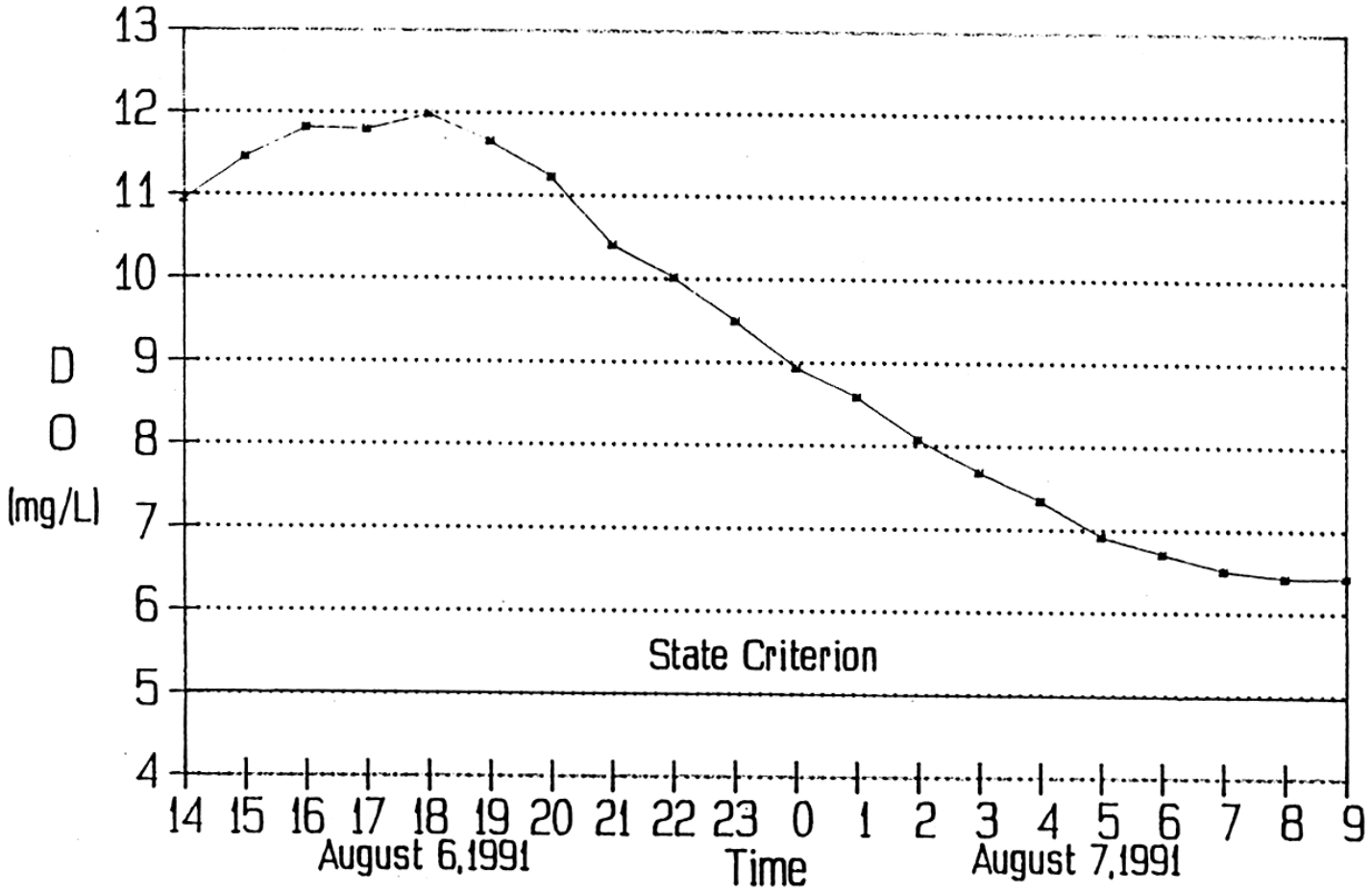


Figure 3: East Fork at Mile 21.7
DO vs Time



which maintains sufficient velocity to allow a substantial reaeration in rif f les. Further downstream in Shope Creek, at mile 0. 4 (Site 10), DO again was low and in violation of criteria. This site was below several more facilities, and stream slope was much lower allowing for water to become nearly stagnant in pools. Streamf low at this site was less than half of that measured at Sites 8 and 9, about 1.4 miles upstream. This is not unusual for summer conditions, when water is lost to evapotranspiration and migration to the groundwater table.

The East Fork at mile 20.0 (Site 11) and mile 17.0 (Site 12) exhibited severe problems. Dissolved oxygen did not exceed 5. 0 mg/L at either location over a day-night cycle (Figures 4 and 5). DO at mile 20.0 was often less than 4.0 mg/L, while the mile 17.0 site generally remained at about 4.5 mg/L. In addition, the cycles did not exhibit the normal type of curves, but were erratic over the period. Both sites are below the majority of the wastewater facilities, and water quality is likely affected by their effluents. This reach also has a heavy tree canopy which would reduce photosynthesis by blocking sunlight during daylight hours, and both sites had oil on the surface.

Williams Creek at mile 0.7 (Site 13) did not violate the DO criteria.

Besides the problems with DO violations and visible oil, a third water quality problem was noted. Specific conductance, a measure of the dissolved solids content of water, was 450 microsiemans per centimeter (uS/cm) in the East Fork at mile 25.4

Figure 4: East Fork at Mile 20.0
DO vs Time

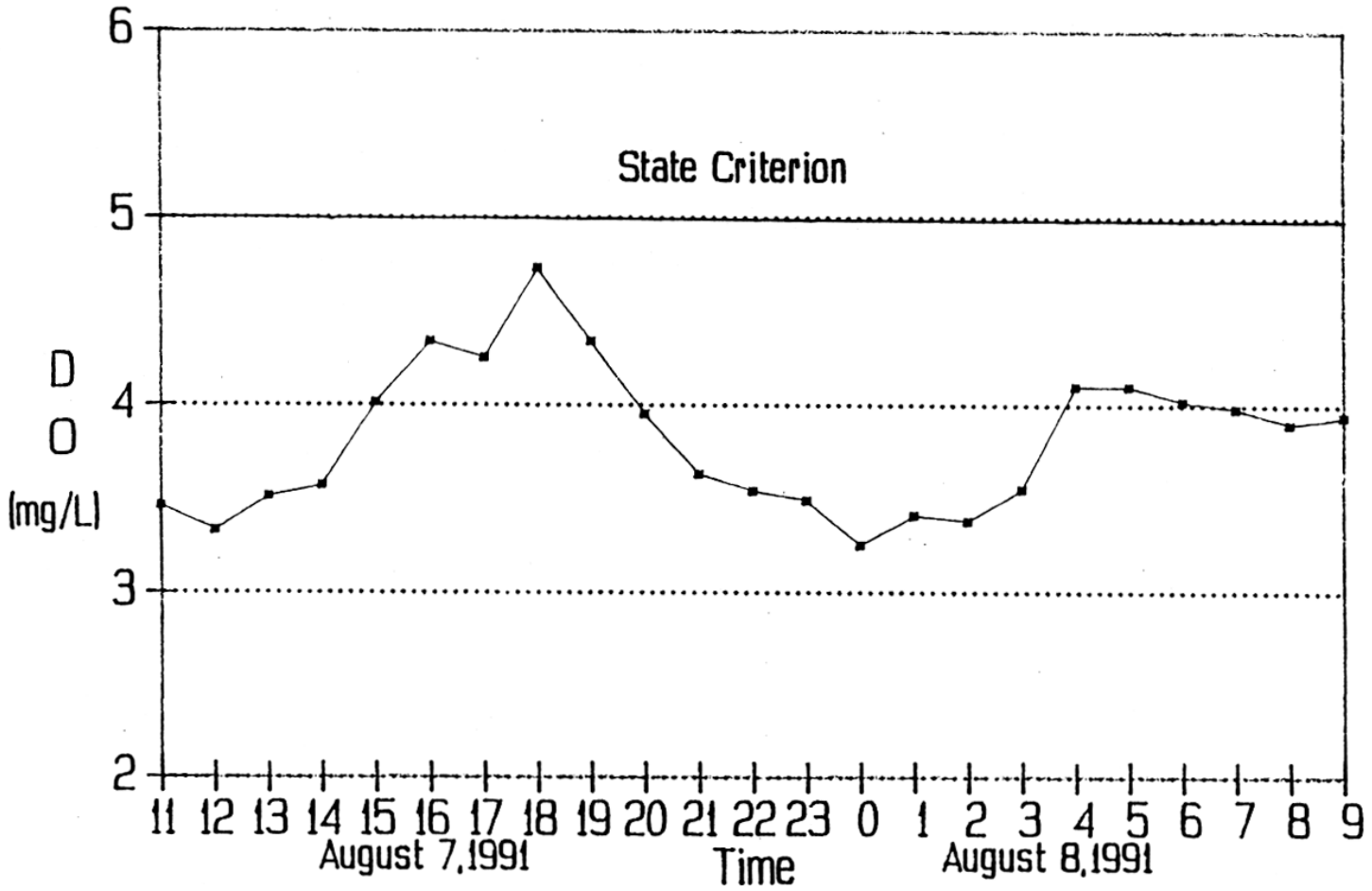
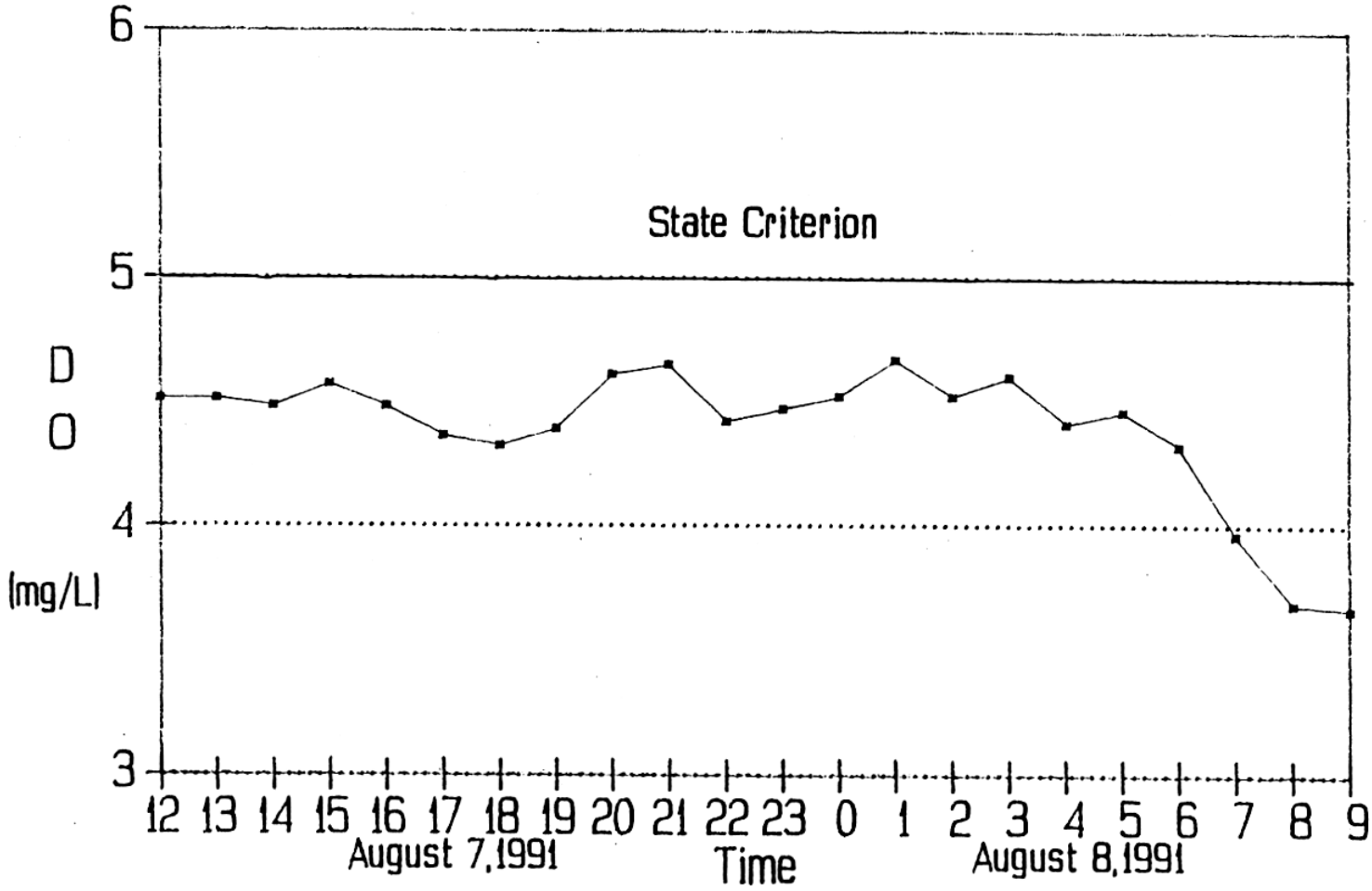


Figure 5: East Fork at Mile 17.0
DO vs Time



(Table 3). This is within a normal range for streams in Kentucky. The value measured in Big Run at mile 0.4 was 1993 uS/cm, which raised the value in the East Fork at mile 22.8 to 1075 uS/cm.

Sources of dissolved solids, which is comprised of calcium, magnesium, sodium, potassium, chloride, sulfate, nitrate, carbonate and bicarbonate ions, include runoff from surface mines, underground mines, oil drilling, wastewater treatment facilities, urban runoff, and possibly landfill leachate. The USGS, in a report published in 1983 documenting water quality impacts from coal mining, sampled 282 sites in the Big Sandy, Levisa Fork, Tug Fork, and Blaine Creek basins of Eastern Kentucky. They reported a median concentration of 336 uS/cm, with a range from 10 to 26,000 uS/cm. Ninety-five percent of the samples were less than 900 uS/cm (5). An examination of topographic maps indicates the likely cause of the high dissolved solids in Big Run is from either mining activities or a large landfill, or both. An attempt was made in the field to track the source of this condition, but was not conclusive. A water sample was collected in Big Run and analyzed for various components: calcium was 190 mg/L, sodium was 132 mg/L. chloride was 46 mg/L, alkalinity was 176 mg/l, and sulfate was 746 mg/L. All are much higher than normal for streams in Kentucky. Sulfate is commonly high in mined areas. Mine drainage is often acidic; however, the USGS has noted that low pH is not common in Kentucky streams because runoff is quickly neutralized by calcareous material and alkaline water in the streams (5). Although pH of the sample was 8.1 units, mine drainage cannot be

ruled out as the source of the high dissolved solids. Discussions with field office staff in the Division of Waste Management indicate that Big Run receives flow from both strip mined areas and from the sediment collection basin at the landfill. Flow occurs year around from the mining areas and much of the time from the sediment basin. The landfill has a stormwater permit from the Division of Water, and a review of Discharge Monitoring Reports from the previous year shows a range of specific conductance from 860 to 1200 uS/cm, sulfate from 321 to 526 mg/L, sodium from 41 to 200 mg/L, and chloride from 110 to 430 mg/L. The landfill itself appears to use an old strip-mined area, which might contribute water to the landfill's sediment basin. This basin is currently being enlarged which would reduce the amount of flow reaching Big Run during low rainfall periods (evaporation from the basin would exceed inflow during dry periods). Specific conductance decreased in the East Fork at mile 21.7 and at mile 20.0. Decreases can occur by the addition of water with lower conductivity and through uptake of the various components by algae (7). Since streamflow increased only slightly in this reach, the likely cause of the reduction is uptake by algae. Specific conductance increased from mile 20 to mile 17, and streamflow nearly doubled in this reach. There are no wastewater facilities between these sites, and no significant tributary streams were seen. This increase may be the result of normal groundwater inflow between these locations or may be additional flow from strip mines located between these sites.

Specific conductance in Shope Creek and Marsh Run is somewhat elevated, and likely caused by wastewater discharges.

CONCLUSIONS AND RECOMMENDATIONS

The East Fork of the Little Sandy River, at least between miles 25.4 to mile 17.0, is of poor quality during low flow summertime conditions. The river and its tributaries are adversely affected by the effluent from 40 package wastewater facilities, causing low dissolved oxygen and algal blooms. Oil was observed on the water surface at all sampling sites in the East Fork. This may only be a temporary condition resulting from an unknown source upstream, or it may be a more constant occurrence from poorly managed oil and gas drilling operations, leaking storage tanks, or other sources. Specific conductance and dissolved solids were very high in Big Run, and are affecting quality in the East Fork. Sources are likely from surface or underground mining scattered throughout the Big Run basin and from a large landfill at mile 1.2 of Big Run.

Based on Kentucky Water Quality Regulations, Title 401 Chapters 5:005 Section 7(3) and 5:055 Section 2(3) and the results from this study, it is recommended that the Division continue to deny new or expansion of package wastewater facilities in this area of the East Fork and its tributaries. Completion of the sewer extension project to eliminate existing package facilities is essential for future growth and development. Once completed, the Division should conduct a follow-up study to document water quality

improvements, and determine if problems with oil and dissolved solids persist. If so, further work will be necessary to determine the sources of these problems and implement remedial actions to eliminate them.

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